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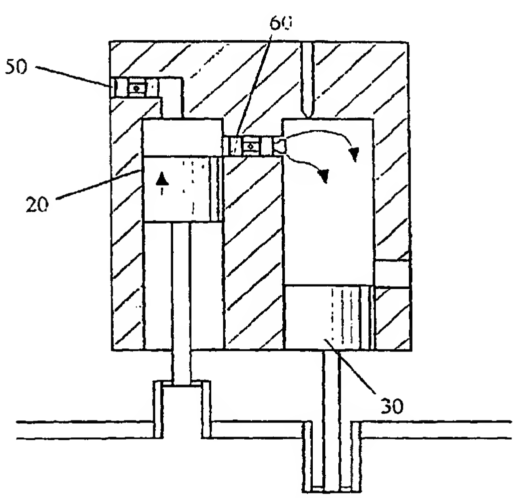
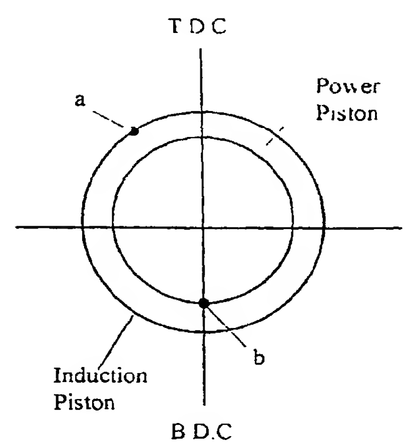
(54) Title: FORCED COAXIALLY VENTILATED TWO STROKE POWER PLANT





(57) Abstract: An internal combustion engine having a power cylinder (200), whereby the power, ventilation (comprising simultaneous intake and exhaust), and compression events within the power cylinder (200) completed define the cycle of the engine, with induction in the induction cylinder (100) being an auxiliary and incidental function to the cycle within the power cylinder (200), such that engine cooling and fuel efficiency are improved over prior art internal combustion engines. Interconnecting the power cylinder and the induction cylinder (100) is a transfer chamber which opens into the top of the power cylinder (200), which chamber in turn is equipped with a one way, pressure responsive transfer valve (60) for allowing air to flow into the power cylinder (200) when pressure therein falls below the pressure in the induction cylinder (100). An exhaust port (12) is likewise positioned near the bottom of the power cylinder (200).

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FORCED COAXIALLY VENTILATED TWO STROKE POWER PLANT

Technical Field

The invention relates to internal combustion engines and, more particularly, to an internal combustion engine having a superior "tri-functional" cycle comprised of three events, namely, ventilation, compression, and power, accomplished in two strokes with greater efficiency than has heretofore been made available through the prior art.

Background Art

Many internal combustion engines operate on a cycle known as the Otto Cycle which has been known since as far back as the year 1801. Whether one is explaining the operation of a two cycle engine or a four cycle engine, the Otto Cycle defines four basic events that occur within the engine during the cycle, namely, intake (or induction), compression, power (or ignition), and exhaust.

In a four stroke engine, approximately one stroke (180 degrees of the 720 degree cycle) is devoted to each event. While modern high speed four stroke engines have attempted to incorporate near simultaneous intake and exhaust, these events still require two separate strokes in a four stroke engine. In such an arrangement, all of the airflow occurs at the top of the cylinder, which tends to help to cool the cylinder head, but which fails to cool the cylinder body. Further, in such a configuration, the power stroke can comprise at best no more than 22% of the cycle, thus limiting the overall power output potential of the engine.

In a two stroke engine, power, exhaust, and intake all occur on the down stroke, followed by additional exhaust and compression on the up stroke. The familiar two stroke internal combustion engine defines four distinct events within the combustion cylinder during its cycle. Beginning with the ignition of the fuel/air mixture in the cylinder, pressure rises above the cylinder head to drive the piston downward through the cylinder. While traveling downward through the cylinder, the piston uncovers an exhaust port to expose the interior of cylinder (which is

under high pressure) to near atmospheric pressure. and the combustion products previously held within the cylinder force themselves out of the cylinder through the exhaust port. The piston continues its downward travel through the cylinder to then uncover an intake port prior to the piston reaching its bottom dead center position. During the return stroke (or "up stroke"). the intake port is first closed by the piston. However. for at least a brief period. the exhaust port remains open as the piston continues to travel upward in its return stroke. Thus. some of the fresh air taken in through the intake port and a portion of any fuel that has thus far been mixed into that air is likewise forced out of the exhaust port until the piston closes the exhaust port by passing it during its return stroke. Once the exhaust port is closed. the remaining air and fuel mixture is compressed. Once compression is completed. the two cycle process is finished. and ignition of the fuel/air mixture occurs once again to start the cycle anew. Unfortunately. the period of the cycle during which the piston travels from its bottom dead center position to the top of the exhaust port results in a significant loss of fresh air and fuel which could be used as part of the combustion product.

Another feature of a typical two stroke engine is that the crankcase in a two stroke engine provides a volume of space in which much of the carburation takes place. This configuration prevents the use of a volume of oil splashing around in the crankcase as is normally the case with a traditional four stroke engine. Thus. in a two stroke engine. oil must be mixed with the fuel prior to its introduction into the cylinder. creating either an additional burden on the user who must mix the fuel and oil prior to use. or requiring more complex fuel and oil delivery systems. while producing an environmentally unfriendly exhaust product which includes burnt oil as a combustion byproduct.

Disclosure of Invention

It is, therefore. an object of the present invention to provide an internal combustion engine which employs a "tri-functional" cycle comprised of three events. namely. ventilation. compression. and power. accomplished in two strokes

with greater efficiency to avoid the disadvantages of the prior art.

It is another object of the present invention to provide an internal combustion engine which introduces cool air into a combustion cylinder to contribute to cooling the entire length of the combustion cylinder.

It is still another object of the present invention to provide an internal combustion engine which increases the efficiency of previously known two cycle engines without increasing the complexity or weight to that of four cycle engine.

It is yet another object of the present invention to provide an internal combustion engine having the benefits of a traditional four cycle engine while extending the power stroke to 25 to 40 percent or more of the total cycle.

It is still yet another object of the present invention to provide an internal combustion engine which increases the amount of air charge which may be retained within a combustion cylinder to participate in the combustion event over what has been previously available in traditional two stroke engines.

It is yet another object of the present invention to provide an internal combustion engine which eliminates the need to mix oil with fuel as in a traditional two stroke engine configuration.

It is another object of the present invention to provide an improved air intake valve for an internal combustion engine capable of improving performance. and which is of simplified construction and less expensive to manufacture than previously known air intake valves.

According to the present invention. the above-described and other objects are accomplished by providing an internal combustion engine having two parallel cylinders. namely. an induction cylinder and a power cylinder. whereby the power. ventilation (comprising simultaneous intake and exhaust). and compression events within the power cylinder completely define the cycle of the engine. with induction in the induction cylinder being an auxiliary and incidental function to the cycle within the power cylinder. such that engine cooling and fuel efficiency are improved over prior art internal combustion engines. Within the combustion cylinder. an intake port is provided at the top of the cylinder. which port in turn is

equipped with a one way, pressure responsive transfer valve for allowing air to flow into the combustion cylinder when pressure therein falls below the pressure in the induction cylinder.

The cycle of the engine of the instant invention is established as follows: Ignition of the fuel air mixture at the head of the power cylinder initiates the power or down stroke of the power piston. Thereafter, exhaust and intake occur nearly simultaneously from somewhat before the bottom dead center position of the power piston until somewhat after the bottom dead center position of the power piston. Finally, the trapped air within the power cylinder is compressed during the remainder of the power piston's up stroke through the remainder of the cycle. Thus, in the configuration of the instant invention, unlike a traditional four stroke engine in which exhaust and intake occur in two separate strokes, no entire stroke is devoted to either of these events, or to both combined. Further, the placement of the exhaust port in the combustion cylinder and the phase difference between the induction piston and the power piston of the instant invention enables the power stroke to be never less than 25 percent, and up to as much of 40 percent, of the entire cycle. Still further, because carburetion is not required for the instant invention, and thus because the crankcase is not involved in the process of inducting air and fuel into the combustion chamber, oil may be circulated in the crankcase as in a traditional four stroke engine, such that mixing of oil with the fuel becomes unnecessary and a cleaner exhaust product is produced over what has been previously attained with traditional two cycle engines.

In an alternate embodiment of the invention, the induction cylinder is replaced with an air tank storing compressed air which may be fed directly into the intake port of the combustion cylinder. The air tank receives compressed air continuously while the engine is operated, from either a turbine driven or crank shaft driven compressor.

Regardless of the source of cooled compressed air, whether it be a first induction cylinder or an air tank, in the event that carburation becomes desired for use in the engine of the instant invention, both of the above-mentioned sources of

cooled compressed air allow the air to be carbureted as it enters the power cylinder, thus avoiding contamination of the crank case.

A design for the one way, pressure responsive transfer valve is also provided, and this comprises two primary components, namely, a fixed valve seat housing and a sliding valve member. The valve seat housing is threaded into an opening in the head of a working chamber on an internal combustion engine. The sliding valve member is configured to reciprocate through the hollow interior of the housing in response to differential pressures on either side of the valve. The sliding member has a hollow chamber running along its interior parallel to its primary axis, and has an opening in a sidewall at the base of the slider member adjacent the valve seat face on the housing. The boring of the interior of the slider member is accomplished such that a smooth transition is provided for directing the stream of air outward from the valve structure. The internal surface of the bore follows the contour of a partial sphere in order to turn the stream of air traveling through the valve from a direction parallel to the primary axis of the valve to a direction perpendicular or nearly perpendicular to the primary axis of the valve, without the dispersal common to the usual type of intake valve used in most internal combustion engines. By providing multiple valves in the head of the cylinder, a swirling effect may be accomplished which enhances the cooling effect of the admitted air on the power cylinder's components (in turn reducing the wear and tear on the same), and more efficiently mixing the fuel/air mixture to provide for increased overall engine efficiency and reduced fuel consumption.

Brief Description of Drawings

Other objects, features, and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiment and certain modifications thereof when taken together with the accompanying drawings in which:

FIG. 1 is a perspective view of a tri-functional (three event), internal

combustion engine according to one embodiment of the present invention in its fully ventilated state.

FIG. 2 is a perspective view of the tri-functional internal combustion engine of FIG. 1 during compression.

FIG. 3 is a perspective view of the tri-functional internal combustion engine of FIGs. 1-2 during ignition/combustion.

FIG. 4 is a perspective view of the tri-functional internal combustion engine of FIGs. 1-3 during the power stroke.

FIG. 5 is a front view of the assembled valve of the instant invention in a closed position.

FIG. 6 is a front view of the slider valve member.

FIG. 7 is a partial cross-sectional view of the slider valve member taken along line A-A of Figure 6.

FIG. 8 is a partial, cross-sectional view of the assembled valve in an open position.

FIG. 9 is a top-down view of a working cylinder with a plurality of valves as described above positioned within the head of the cylinder introduce a plurality of smooth, continuous, laminar streams of air into the head of the cylinder.

FIG. 10 is a perspective view of a dual-cylinder tri-functional internal combustion engine according to an alternate embodiment of the present invention, wherein the power piston is at a top dead center position.

FIG. 11 is a sectional view of the internal combustion engine of Fig. 10, wherein the power piston is traveling through its down stroke.

FIG. 12 is a sectional view of the internal combustion engine of Figs. 10-11, wherein the power piston is at a bottom dead center position.

FIG. 13 is a sectional view of the internal combustion engine of Figs. 10-12, wherein the power piston is traveling through its up stroke.

Best Mode(s) for Carrying Out the Invention

Figures 1 through 4 diagramatically depict a tri-functional (three event).

internal combustion engine according to one embodiment of the present invention. As shown in Figure 1, the internal combustion engine of the instant invention comprises an engine block 10 having a preferably vertically oriented power cylinder (shown generally at 200). While Figures 1 through 4 depict power cylinder 200 as a vertically oriented cylinder, it should be noted that the cylinder may alternately be arranged at an angle. Power cylinder 200 houses a power piston 30 which is configured for reciprocal movement through power cylinder 200. A standard piston rod 31 attaches power piston 30 to crankshaft 40.

A compressed air inlet port 13 enters the "head" of power cylinder 200, and housed within inlet port 13 is a one way pressure responsive transfer valve 60 (described in greater detail below) which allows a charge of compressed fresh air to travel from compressed air inlet port 13 to power cylinder 200 when the pressure in power cylinder 200 falls and causes a pressure differential across pressure responsive transfer valve 60

One or more exhaust ports 12 are positioned within a side wall of power cylinder 200 located near the bottom of the power piston's travel.

A fuel injection port 70 is provided at the top of power cylinder 200. Likewise, while the configuration of the instant invention is intended for use as a high compression engine which causes the combustion event to occur in power cylinder 200 as a result of the heat generated during the compression of the air/fuel mixture, a glow plug or spark plug (not shown) may optionally be provided at the top of power cylinder 200 adjacent fuel injection port 70 to further promote the combustion event.

The method of tri-functional ventilation, compression, and power of the instant invention is carried out in only two strokes as follows, with reference to FIGs. 1-4.

FIG. 1 illustrates the fully ventilated bottom dead center (BDC) position, wherein the exhaust port(s) 12 are fully unobstructed allowing ventilation of the entire cylinder. after power piston 30 passes exhaust port 12 during its down stroke, exhaust gasses flow out of power cylinder 200 through exhaust port 12, thus

decreasing the pressure in power cylinder 200 and allowing transfer valve 60 to open, in turn allowing a charge of compressed, fresh air to flow from induction cylinder 100 into power cylinder 200. While exhaust port 12 remains open, the inflow of fresh air through transfer valve 60 ensures that any remaining combustion products are displaced out of power cylinder 200.

FIG. 2 illustrates the compression event wherein the piston 30 is now on the upward, or return, stroke, and the exhaust port(s) 12 are closed. As power cylinder 30 reaches a position 40° past its BDC position it once again closes off exhaust valve 12. Once exhaust valve 12 is closed, the cooler air which has just passed through transfer valve 60 into power cylinder 200 will have been absorbing heat from all the surfaces of power cylinder 200 and the crown of power piston 30, causing it to increase in pressure, thereby forcing closed pressure-responsive transfer valve 60. The power piston 30 continues its up stroke to compress the remaining fresh air charge within power cylinder 200. This arrangement creates a high pressure condition within power cylinder 200 which in turn causes pressure responsive transfer valve 60 to automatically close, thus trapping the remaining charge of fresh air for use in the next combustion event.

FIG. 3 illustrates the ignition/combustion event wherein the piston 30 is now at at TDC. Fuel has been, or is now injected in through injector 70. If diesel or compression ignition is used, the fuel will now be ignited by the heat of the compressed air. Alternately, if a spark is required, ignition will be made to occur by a spark plug or glow plug (not shown) in a known manner. The combustion event within power cylinder 200 creates an increasing pressure at the top of power piston 30 which in turn drives power piston 30 downward as the combustion gasses expand.

FIG. 4 illustrates the power stroke wherein the aforesaid rapid increase in pressure, as a result of combustion, forces the piston 30 down, imparting power to the crank shaft 40 and fly wheel. The top edge of power piston 30 falls below the upper extent of exhaust port(s) 12, thus starting to allow the exhaust gasses to be expelled from power cylinder 200. The power stroke ends as the piston 30 uncovers

the exhaust port(s) 12 and the pressurized combustion products leave, again beginning the ventilation process of Fig. 1. The sudden release of pressure within power cylinder 200 once exhaust port 12 has been exposed in turn causes pressure responsive transfer valve 60 to open.

During the time that the power piston 30 exposes exhaust port 12, power piston 30 will travel through the remainder of its downstroke to the extent of the remainder of its travel distance, and back up during its up stroke to again close exhaust port 12. There is a continuous inflow of fresh air via the pressure responsive intake valve 60 and into intake port 13. This ensures that all remaining combustion products within power cylinder 200 are washed out of power cylinder 200 until exhaust valve 12 again becomes sealed.

To supply the continuous inflow of fresh air via the pressure responsive intake valve 60 and into intake port 13, a source of compressed air may be coupled to compressed air inlet port 13, and this may be a storage vessel storing compressed air. The storage vessel is connected by a transfer chamber to the air inlet of power cylinder 200 which houses transfer valve 60. As the ventilation event allows pressure in the power cylinder to decline to less than that in the storage tank, transfer valve 60 will open to allow fresh air into the combustion cylinder. Such source of air is cooled separately from the power cylinder 30, such that a denser and more oxygen rich mixture is present in the combustion chamber at the onset of the ignition event than has previously been available in prior art engines. The forced flooding of the combustion chamber from the top down, as the exhaust and induction events occur simultaneously, will have the incidental advantage of collecting heat from the cylinder wall and the piston crown, as the earliest of the new air washes all the way through the cylinder as it follows the last of the exhaust. It should be understood by those skilled in the art that alternative sources of compressed air may be used. For example, a separate induction piston may be employed (as will be described), or any other forced air source.

As mentioned briefly above. valve 60 is configured as a pressure responsive valve which opens automatically in response to a differential pressure of approximately 1 psi. In order to provide such a readily responsive valve. and as shown more particularly in Figures 5-8. valve 60 comprise a valve seat housing 10 and a slider valve member 20 configured to reciprocate through the hollow interior of valve seat housing 10. automatically opening and closing in response to differential pressures on either side of the valve of as little as 1 psi. Valve seat housing 10 comprises a generally cylindrical body preferably formed of a hard metal having a bore extending there through. The bore in valve seat housing 10 is configured as an elongate. cylindrical bore 11 extending from the top face of housing 10 to slightly above the bottom face of housing 10. and a flared valve seat 12 interposed between cylindrical bore 11 and the bottom face of housing 10. As explained in greater detail below. flared valve seat 12 is configured to mate with the bottom flared portion 23 of slider valve member 20 when the valve is closed. Extending radially inward from the sidewall of cylindrical bore 11 is a positioning pin 14. As explained in greater detail below, positioning pin 14 is configured to ride within a channel 22 on slider valve member 20 to prevent the rotation of slider valve 20 about its primary axis. thus maintaining the air flow from the valve in the desired direction during operation. Valve seat housing 10 is preferable provided along at least a portion of its external cylindrical wall with a series of threads 13 configured to mount valve seat housing 10 in a cooperating screw-threaded opening provided in the head of a cylinder in an internal combustion engine.

As shown more particularly in the side view of slider valve 20 of Figure 6. slider valve 20 comprises a generally elongate shaft: preferably formed of steel or ceramic. or a similarly configured hard and temperature resistant material. having a flared face 23 at its bottom portion.

Flared face 23 is contoured to mate with flared valve seat 12 on valve housing 10. such that when the valve assembly is in its fully closed position (as shown in Figure 5). the bottom-most portion of slider valve 20 lies flush with the bottom face of valve housing 10. Slider valve 20 is provided at its upper portion

with an annular ring 21 rigidly attached to slider valve 20. Annular ring 21 serves as a stop to limit the downward travel of slider valve member 20 as it reciprocates through valve housing 10 to open and close the valve assembly.

Slider valve 20 is likewise provided near its bottom portion with a circular air outlet port 24 positioned in a sidewall of slider valve member 20. Air outlet port 24 opens into and intercepts a vertical bore 25 extending through a majority of the slider valve member's major axis. As shown more particularly in the partial cross-sectional view of the slider valve member of Figure 7 (taken along line A-A of Figure 6), the point at which vertical bore 25 intercepts side port 24 defines a cavity within the slider valve having the contour of the interior surface of a partial sphere having a radius R, such that the transition of the bore surface from vertical bore 25 to sidewall port 24 is carried out along the interior surface of such sphere. It has been found that by providing such a smooth bore surface following the contour of a sphere, the greatest potential for maintaining laminar flow of the air traveling through the valve structure is achieved, in turn improving the effectiveness of mixing the air with the fuel injected into the cylinder and thus the overall efficiency of the engine. To further enhance the flow of air through the valve and maintain its laminar nature, the radius R of the portion of the sphere interconnecting vertical bore 23 and side port 24 is preferably the same as the radii of both vertical bore 23 and side port 24, thus eliminating any ridges or narrowing of the flow channel which might inhibit flow or otherwise support the development of turbulent regions within slider valve 20. The formation of such a continuous flow channel may be achieved using a ball mill to bore both vertical bore 23 and side port 24, leaving a concave spherical surface at the points at which these two openings intercept one another.

As mentioned above, slider valve 20 is also equipped with a shallow channel 22 positioned in its external sidewall. Channel 22 is configured with a dimension slightly larger than positioning pin 14 in valve seat housing 10, thus allowing positioning pin 14 to move freely up and down through channel 22 during operation of the valve while preventing rotation of slider valve 20. Thus, when the valve

assembly is installed in the head of a cylinder, the air flow produced from the valve when it is in its open position is in a constant, fixed direction.

Referring now to the partial, cross-sectional view of Figure 8, when the valve is subjected to a differential pressure of 1 psi or greater so as to create a vacuum on the valve seat side of valve housing 10 (such as during the intake stroke in an internal combustion engine), slider valve member 20 moves downward through valve body 10 until annular ring 21 positioned at the top of slider valve 20 abuts the top face of valve body 10. Rotation of slider valve 20 about its primary axis as it travels through valve body 10 is prevented by the interaction between guide pin 40 with channel 22 on the sidewall of slider valve 20. When slider valve 20 has assumed a fully open position (as shown in Figure 8), outlet port 24 is fully exposed to the environment within the working chamber, in turn allowing air to flow through slider valve 20 through vertical bore 25 and out from port 24 in a continuous, smooth, laminar stream. A spring 14 is provided within valve housing 20 which acts against annular ring 21 to bias slider valve 20 towards its closed position.

Finally, as shown in the top-down view of a working chamber of Figure 9, a plurality of valves as described above may be positioned within the head of the cylinder of an internal combustion engine to introduce a plurality of smooth, continuous, laminar streams of air into the head of the cylinder. Such a combination of flows which produces a swirling effect within the cylinder has been found to have a significant cooling effect on the cylinder, in turn reducing the wear on the cylinder and piston experienced during engine operation. Likewise, the swirling effect produced through the introduction of air from multiple valves of the instant invention provides for more efficient mixing of the fuel/air mixture prior to combustion than has been previously available through prior art devices, in turn providing increased overall engine efficiency and reduced fuel consumption.

As explained in greater detail above, it has been found that the foregoing valve ensures ease of operation of the valve in response to a differential pressure of as little as 1 psi, thus greatly reducing the load exerted on the internal combustion

engine of the instant invention during the intake or induction stroke of the induction cylinder. while ensuring a readily responsive transfer of fresh air into the working chamber. The design of the valve of the instant invention provides for automatic. pressure responsive actuation. such that the need for mechanical. electrical. or electromechanical valve actuators is eliminated. while maintaining a vastly simplified construction over previously known valves. Such simplified construction in turn reduces the manufacturing costs of the valve unit.

It should be readily apparent to those of ordinary skill in the art that the improved valve of the instant invention may be applied to various types of internal combustion engines. such as vehicle engines. marine engines. and industrial engines. The improved valve of the instant invention may likewise be applied to internal combustion engines using spark ignition and/or incorporating fuel injection systems. as well as diesel engines employing compression ignition.

FIGs. 10-13 diagramatically depict another embodiment of the dual cylinder. tri-functional (three event). internal combustion engine that uses a separate induction cylinder as a source of air rather than the compressed air supply described above. Like reference numerals represent like parts.

The embodiment of FIGs. 10-13 comprises an engine block 10 having a pair of preferably vertically oriented parallel cylinders. namely. an induction cylinder (shown generally at 100). and a power cylinder (shown generally at 200). While Figures 10 through 13 depict induction cylinder 100 and power cylinder 200 as vertically oriented parallel cylinders. it should again be noted that the cylinders may alternately be arranged at angles to one another. as in a typical V-arrangement for an internal combustion engine. Induction cylinder 100 houses an induction piston 20 which is configured for reciprocal movement through induction cylinder 100. A standard piston rod 21 attaches induction piston 20 to a crankshaft 40 as before. Likewise. power cylinder 200 houses a power piston 30 which is configured for reciprocal movement through power cylinder 200. One or more exhaust ports 12 are located near the lower portion of power cylinder 200. A standard piston rod 31 attaches power piston 30 to crankshaft 40. In the preferred embodiment of the

instant invention, crankshaft 40 is configured such that induction piston 20 is phased to move 140 degrees in advance of power piston 30. However, such phase separation may vary from 90 to 180 degrees while maintaining the functionality of the instant invention. While the embodiment depicted in Figures 10 through 13 discloses a phase difference of 140 degrees, it is important to note that the precise phase difference is a function of the location of exhaust port 12 in power cylinder 200, and the angular position of power piston 30 during its cycle, and more particularly its downward power stroke, when power piston 30 initially uncovers exhaust port 12. The precise phase difference between induction piston 20 and power piston 30 is preferably 2 times the number of degrees between bottom dead center of power piston 30 (i.e., 180 degrees) and the angular position of power piston 30 during its 360 degree cycle at which it initially uncovers exhaust port 12. It has been found that this precise arrangement ensures that induction piston 20 reaches its top dead center position, thus maximally compressing the charge of air in induction cylinder 100 and ensuring transfer of that entire charge to power cylinder 200, just as power piston 30 closes exhaust port 12. This arrangement in turn assures that the maximum amount of fresh air is made available for combustion within power cylinder 200, thus increasing the efficiency of the engine of the instant invention over prior art designs which require recombustion of leftover combustion products in the power cylinder, or which utilize contaminated exhaust gasses from the engine crank case as a part of the combustion product.

An air inlet port (shown generally at 11) is provided at one end of engine block 10 and is in fluid communication with induction cylinder 100. A fresh air plenum chamber (not shown) directs fresh atmospheric air, uncontaminated from combustion byproducts of the engine cycles, to air inlet port 11. Housed within air inlet port 11 is a one way pressure responsive valve 50 (described in greater detail below) which allows fresh air to travel from the plenum chamber into induction cylinder 100 when the pressure in induction cylinder 100 falls below the pressure on the inlet side of valve 50.

In order to regulate the amount of air that is ultimately directed to the power

cylinder, induction cylinder 100 may optionally be provided with a mechanically-actuated or electromechanically-actuated relief valve located near the top of induction cylinder 100. The relief valve allows air that is unwanted and unnecessary for the combustion event to occur to escape from induction cylinder 100 prior to its transfer of air to power cylinder 200. Such air is thus ejected from induction cylinder 100 untainted by fuel and exhaust, and thus creates no hazardous environmental effects. As a further form of economy, such dispelled air may be stored under pressure in a compressed air vessel and may thereafter be used to operate many pneumatic ancillary systems of numerous types in vehicles, water craft and aircraft.

A transfer port connecting the hot and cold cylinders near their "heads" (shown generally at 13) is positioned between induction cylinder 100 and power cylinder 200 to allow fluid communication between each cylinder. Housed within transfer port 13 is a one way pressure responsive transfer valve 60 (described in greater detail previously) which allows a charge of compressed fresh air to travel from induction cylinder 100 to power cylinder 200 when the pressure in power cylinder 200 falls below the pressure in induction cylinder 100.

One or more exhaust ports 12 are positioned within a side wall of power cylinder 200 located near the bottom of the power piston's travel. After power piston 30 passes exhaust port 12 during its down stroke, exhaust gasses flow out of power cylinder 200 through exhaust port 12, thus decreasing the pressure in power cylinder 200 and allowing transfer valve 60 to open, in turn allowing a charge of compressed, fresh air to flow from induction cylinder 100 into power cylinder 200. While exhaust port 12 remains open, the inflow of fresh air through transfer valve 60 ensures that any remaining combustion products are displaced out of power cylinder 200. As power piston 30 moves upward, it closes exhaust port 12, thus trapping the remaining charge of fresh air for use in the next combustion event.

A fuel injection port 70 is provided at the top of power cylinder 200. As described previously, the configuration of the instant invention is intended for use as a high compression engine which causes the combustion event to occur in power

cylinder 200 as a result of the heat generated during the compression of the air/fuel mixture. Alternately, a glow plug or spark plug (not shown) may optionally be provided at the top of power cylinder 200 adjacent fuel injection port 70 to further promote the combustion event.

In the dual-cylinder embodiment, the method of tri-functional ventilation, compression, and power of the instant invention is carried out in only two strokes as follows. Referring first to Figure 13, in which induction piston 20 is at its top dead center (TDC) position, the next movement of induction piston 20 will be downward through induction cylinder 100. At this instance, as shown in the graph of Figure 13, the power piston 30 position is shown at approximately 220°, or 140° from its TDC position as it is traveling upward. It is also important to note that at this instance, power piston 30 has just closed exhaust port 12 such that all fresh air remaining within power cylinder 200 will be compressed as power piston 30 continues its upward stroke.

In the cylinders illustrated on the left, the power piston 30 is now at TDC; fuel has been, or is now injected. If diesel or compression ignition is used, the fuel will now be ignited by the heat of the compressed air, or if a spark is required, it will be made to occur (spark plug not shown). The resulting combustion will cause a rapid increase in pressure within the cylinder.

The aforesaid rapid increase in pressure, as a result of combustion, forces the power piston 30 down, imparting power to the crank shaft and fly wheel. The Power stroke ends as the piston uncovers the exhaust ports 12, and the pressurized combustion products leave, beginning the Ventilation Process.

As induction piston 20 begins to travel downward through induction cylinder 100, pressure responsive valve 50 opens as a result of the slight underpressure condition created within induction cylinder 100 as induction piston 20 begins its downward stroke. The structure of valve 50 is preferably identical to valve 60, and this enables it to open with only a very slight underpressure condition within induction cylinder 100, such that the task traditionally placed on an internal combustion engine as a result of the vacuum draw established during an intake

stroke is vastly reduced. More particularly, assuming that average atmospheric air pressure at sea level is approximately 14.7 PSI, the transfer valve 50 of the instant invention is designed such that with the transfer valve closed, less than a one pound differential pressure will be sufficient to open the valve. Such sensitivity in transfer valve 50 will ensure closure of the valve as air is trapped and begins to be compressed within power cylinder 200. As pressure responsive valve 50 opens, fresh air is 1 introduced into induction chamber 100 above induction piston 20 through air inlet 11. As shown in Figure 10, as induction piston 20 proceeds through its downstroke within induction cylinder 100, valve 50 remains open to allow a maximum charge of fresh air to be inducted into cylinder 100. When induction piston 20 has traveled through approximately 140° (and is thus approximately 40° from bottom dead center (BDC) position), power piston 30 has reached its TDC position, fully compressing the fuel and air mixture and initiating the combustion event within power cylinder 200.

The combustion event within power cylinder 200 creates an increasing pressure at the top of power piston 30 which in turn drives power piston 30 downward as the combustion gasses expand. As shown in Figure 11, as power piston 30 continues through its downward stroke, induction piston 20 passes its BDC position and begins its up stroke. Once induction piston 20 begins its up stroke, pressure responsive valve 50 automatically closes to allow the charge of fresh air that has been admitted to induction cylinder 100 to be compressed. Induction piston 20 then continues to compress the charge of fresh air contained within induction cylinder 100 until power piston 30 again reaches the top of exhaust port 12, at which time the exhaust event commences, allowing a drastic and near immediate reduction of pressure in power cylinder 200 when induction piston 20 is 80 degrees prior to TDC.

Immediately following the piston arrangement depicted in Figure 11, the top edge of power piston 30 falls below the upper extent of exhaust port 12, thus starting to allow the exhaust gasses to be expelled from power cylinder 200. The sudden release of pressure within power cylinder 200 once exhaust port 12 has been

exposed in turn causes pressure responsive transfer valve 60 to open. as shown more particularly in FIG. 12. As power piston 30 travels from approximately 40° prior to its BDC position (shown in Figure 11) to its BDC position, transfer valve 50 remains open as induction piston 20 continues its upward stroke. During the time that the power piston 30 exposes exhaust port 12. power piston 30 will travel through the remainder of its downstroke approximately 11.8% of its total travel distance. and back up during its up stroke approximately another 11.8% of its total travel distance to again close exhaust port 12, at a comparatively slower rate of speed than the rise of induction piston 20 during its up stroke. which in turn rises approximately 40.5% of its total travel distance to reach its TDC position. thus further compressing the air remaining withing induction cylinder 100 and simultaneously directing it into power cylinder 200. The continuous inflow of fresh air from induction cylinder 100 to power cylinder 200 while exhaust port 12 remains open also ensures that all remaining combustion products within power cylinder 200 are washed out of power cylinder 200 until exhaust valve 12 again becomes sealed.

Referring once again to Figure 13. as induction piston 20 reaches its TDC position, power cylinder 30 reaches a position 40° past its BDC position. at which it once again closes off exhaust valve 12. Once exhaust valve 12 is closed. the cooler air which has just passed from induction cylinder 100 through transfer valve 60 into power cylinder 200 will have been absorbing heat from all the surfaces of power cylinder 200 and the crown of power piston 30. causing it to increase in pressure, thereby forcing closed transfer valve 60. The power piston 30 continues its up stroke to compress the remaining fresh air charge within power cylinder 200. while induction piston 20 starts its induction stroke. This arrangement creates a high pressure condition within power cylinder 200 which in turn causes pressure responsive transfer valve 60 to automatically close.

As mentioned briefly above. valves 50 and 60 are both configured as pressure responsive valves which open automatically in response to a differential pressure of approximately 1 psi. In order to provide such a readily responsive

valve. and as shown and described previously with regard to Figs. 5-8. both valve 50 and valve 60 comprise a valve seat housing 10 and a slider valve member 20 configured to reciprocate through the hollow interior of valve seat housing 10. automatically opening and closing in response to differential pressures on either side of the valve of as little as 1 psi.

The power cylinder 200 of the instant invention and the induction cylinder 100 (assuming an induction cylinder as set forth in the first above-described embodiment is utilized) are each preferably lined with an inner cylinder composed of a hard and heat resistant substance such as polished cast iron. although any similar hard and heat resistant substance would likewise suffice. The inner cylinder is preferably pressed into steel block 10. Alternately. the inner cylinder 10 may be set into block 10 during the molding process. as the block may alternately be formed from a pourable material. such as concrete. ceramic slip. or epoxy. The inner cylinder is provided with a plurality of small and very numerous perforations clustered together above the BDC position of the power piston. This configuration of perforations allows a generous sectional area for exhaust while protecting the piston rings of power piston 30. and maintaining a continuously smooth surface against which the piston rings (or a ringless piston) can slide. Outside of the inner cylinder. block 10 is provided with a first exhaust plenum immediately adjacent the cylinder liner. A controllable obstruction. such as an off-center cam or similarly configured device. may optionally be provided in order to regulate the flow of exhaust gasses.

Having now fully set forth the preferred embodiments and certain modifications of the concept underlying the present invention. various other embodiments as well as certain variations and modifications of the embodiments herein shown and described will obviously occur to those skilled in the art upon becoming familiar with said underlying concept. For example. multiple devices as described above may be utilized to supply fresh air. and multiple fresh air inlet valves and transfer valves may be provided in order to increase the airflow into each respective cylinder. It should be understood. therefore. that the invention may be

practiced otherwise than as specifically set forth herein.

Industrial Applicability

In conventional two-stroke engines, the period of the cycle during which the piston travels from its bottom dead center position to the top of the exhaust port results in a significant loss of fresh air and fuel which could be used as part of the combustion product. In addition, the crankcase provides a volume of space in which much of the carburetion takes place. This configuration prevents the use of a volume of oil splashing around in the crankcase as is normally the case with a traditional four stroke engine. Thus, in a two stroke engine, oil must be mixed with the fuel prior to its introduction into the cylinder, creating either an additional burden on the user who must mix the fuel and oil prior to use, or requiring more complex fuel and oil delivery systems, while producing an environmentally unfriendly exhaust product which includes burnt oil as a combustion byproduct. There would be a significant industrial demand for an improved internal combustion engine which enables the air being inducted into a combustion chamber to participate in cooling the entire cylinder, which increases the efficiency of previously known two cycle engines without requiring the complexity and additional weight associated with four cycle engines, and which prevents the need to use a fuel/oil mixture in a two cycle engine configuration.

Claims

1. In a two stroke internal combustion engine comprising an elongate power cylinder having a piston operatively connected to a drive shaft through a connecting rod and mounted for reciprocating movement therein between a top dead center position adjacent a first end of said power cylinder and a bottom dead center position adjacent a second end of said power cylinder, an air inlet adjacent said first end of said power cylinder interconnecting said power cylinder with a source of compressed air, an automatic, pressure responsive valve mounted within said air inlet, and an exhaust outlet positioned away from said second end of said power cylinder a sufficient distance such that said exhaust outlet is entirely exposed when said piston is at said bottom dead center position and is entirely blocked when said piston is at said top dead center position, a method of conducting a two stroke cycle within said power cylinder comprising the steps of:

a. admitting a charge of compressed air into said power cylinder in response to a pressure differential across said pressure responsive valve created by the downwardly moving piston exposing said exhaust outlet, said charge of compressed air being admitted while said exhaust outlet is at least partially exposed;

b. compressing said air in the power cylinder by the upwardly moving piston with exhaust port closed;

c. adding fuel to said charge of air during such compression to create a compressed air/fuel mixture;

d. combusting said air/fuel mixture to drive said piston downward through said power cylinder; and

d. ventilating combustion products from said power cylinder at the instant that said piston begins to expose said exhaust port during a downstroke of said piston and simultaneously with admitting fresh, cool, compressed air into said power cylinder to create an airflow along a longitudinal axis of said power cylinder from said air inlet to said exhaust outlet;

whereby the creation of an airflow along a longitudinal axis of said power

cylinder from said air inlet to said exhaust outlet cools said power cylinder as such air travels from said air inlet to said exhaust outlet.

2. The method according to claim 1, wherein when said piston moves from said bottom dead center position back toward said top dead center position, said exhaust outlet is closed and pressure builds in said power cylinder until said pressure responsive valve closes, thereby trapping and compressing air therein.

3. A forced coaxially ventilated two stroke power plant comprising:

a source of compressed air; and

an elongate power chamber having a first end and a second end opposite said first end, said power chamber in fluid communication with said source of compressed air, said power chamber further comprising:

a piston mounted for reciprocating movement within said power chamber between a top dead center position adjacent said first end and a bottom dead center position adjacent said second end, said piston being mounted to a connecting rod which in turn is operatively connected to a drive shaft;

an air inlet adjacent said first end, said air inlet interconnecting said source of compressed air and said power chamber;

a first automatic pressure responsive valve mounted within said air inlet for admitting a charge of compressed air from said source of compressed air in response to a pressure differential across said first pressure responsive valve; and

an exhaust outlet positioned away from said second end a sufficient distance such that said exhaust port is entirely exposed only when said piston is at said bottom dead center position, and is at least partially blocked by said piston at all other times; whereby exposure of said exhaust outlet creates an airflow generally coaxial with said power chamber flowing from said air inlet to said exhaust outlet, said airflow cooling said power chamber as it flows from said air inlet to said exhaust outlet.

4. The forced coaxially ventilated two stroke power plant of claim 3. said first automatic. pressure responsive valve further comprising:

a valve seat housing. said valve seat housing further comprising.

a first bore extending through said valve seat housing from a top face of said valve seat housing to a bottom face of said valve seat housing. said first bore defining a flared valve seat adjacent said bottom face.

and a slider valve member configured for reciprocating movement through said bore. said slider valve member further comprising: an elongate member having an outwardly flared bottom. said outwardly flared bottom configured to mate with said valve seat to close said valve:

guide means for guiding said slider valve through said valve seat housing:

a side port extending into a side wall of said elongate member: and

a second bore extending through said slider valve member from a top face of said slider valve member to said side port.

5. The forced coaxially ventilated two stroke power plant of claim 3. said source of compressed air further comprising a compressed air storage tank.

6. The forced coaxially ventilated two stroke power plant of claim 3. said source of compressed air further comprising an induction cylinder. said induction cylinder further comprising:

an air induction inlet in fluid communication with atmospheric air:

an air outlet in fluid communication with said air inlet of said power chamber; and

a piston mounted for reciprocating movement within said induction cylinder between a top dead center position and a bottom dead center position.

7. The forced coaxially ventilated two stroke power plant of claim 6. further comprising:

a second automatic. pressure responsive valve mounted within said air

induction inlet of said induction cylinder.

8. A forced coaxially ventilated two stroke power plant comprising:

air supply means for supplying compressed air;

first automatic pressure responsive valve means in fluid communication with said air supply means for admitting a charge of said compressed air from said air supply means in response to a pressure differential;

an elongate power cylinder in fluid communication with said first automatic pressure responsive valve means having a first end and a second end opposite said first end. and piston means operatively connected to a drive shaft and mounted for reciprocal movement within said power cylinder between a top dead center position adjacent said first end and a bottom dead center position adjacent said second end, said power cylinder in fluid communication with said air supply means. said power cylinder configured for compressing a mixture of fuel and air and thereafter combusting said mixture to transfer power through said piston means to a drive shaft;

and means for cooling said power cylinder along its longitudinal axis during ventilation of said power cylinder.

9. The forced coaxially ventilated two stroke power plant of claim 8. said means for cooling said power cylinder further comprising:

air inlet means interconnecting said power cylinder and said air supply means;

exhaust means; and

said first pressure responsive valve means being mounted within said air inlet means.

10. The forced coaxially ventilated two stroke power plant of claim 9. wherein said air inlet means is positioned adjacent said first end. and said exhaust means is positioned away from said second end a sufficient distance such that said

exhaust port is entirely exposed only when said piston is at said bottom dead center position, and is at least partially blocked by said piston at all other times.

11. The forced coaxially ventilated two stroke power plant of claim 10, wherein said first automatic, pressure responsive valve means is configured to automatically open upon ventilation of said power cylinder through exposure of said exhaust means, such that an airflow generally coaxial with said power cylinder is generated flowing from said air inlet means to said exhaust means, and cools said power cylinder as it flows from said air inlet means to said exhaust means.

12. The forced coaxially ventilated two stroke power plant of claim 11, said first automatic, pressure responsive valve means further comprising:

a valve seat housing, said valve seat housing further comprising,

a first bore extending through said valve seat housing from a top face of said valve seat housing to a bottom face of said valve seat housing, said first bore defining a flared valve seat adjacent said bottom face,

and a slider valve member configured for reciprocating movement through said bore, said slider valve member further comprising: an elongate member having an outwardly flared bottom, said outwardly flared bottom configured to mate with said valve seat to close said valve;

guide means for guiding said slider valve through said valve seat housing;

a side port extending into a side wall of said elongate member; and

a second bore extending through said slider valve member from a top face of said slider valve member to said side port.

12. The forced coaxially ventilated two stroke power plant of claim 9, said air supply means further comprising a compressed air storage tank.

13. The forced coaxially ventilated two stroke power plant of claim 9, said air supply means further comprising an induction cylinder having a first end and a

second end, said induction cylinder further comprising:

an air induction inlet in fluid communication with atmospheric air;

an air outlet in fluid communication with said air inlet means of said power cylinder; and

a piston mounted for reciprocating movement within said induction cylinder between a top dead center position adjacent said first end of said induction cylinder and a bottom dead center position adjacent said second end of said induction cylinder.

14. The forced coaxially ventilated two stroke power plant of claim 14, further comprising a second automatic, pressure responsive valve means mounted within said air induction inlet.

15. In an internal combustion engine having at least one working cylinder, said cylinder further comprising a cylinder head, an automatic, pressure responsive air intake valve comprising: a valve seat housing, said valve seat housing further comprising: a first bore extending through said valve seat housing from a top face of said valve seat housing to a bottom face of said valve seat housing, said first bore defining a flared valve seat adjacent said bottom face; and a slider valve member configured for reciprocating movement through said bore, said slider valve member further comprising: an elongate member having an outwardly flared bottom, said outwardly flared bottom configured to mate with said valve seat to close said valve; guide means for guiding said slider valve through said valve seat housing; a side port extending into a side wall of said elongate member; and a second bore extending through said slider valve member from a top face of said slider valve member to said side port.

16. The automatic, pressure responsive air intake valve of claim 15, said valve seat housing further comprising: means for attaching said valve seat housing to an opening in said cylinder head.

17. The automatic, pressure responsive air intake valve of claim 16, said means for attaching said valve seat housing further comprising screw threads circumscribing at least a portion of an exterior surface of said valve seat housing.

18. The automatic, pressure responsive air intake valve of claim 17, said valve seat housing further comprising a pin extending radially inward into said first bore in said valve seat housing, said pin engaging said guide means on said slider valve so as to prohibit rotation of said slider valve and limit the stroke of said slider valve.

19. The automatic, pressure responsive air intake valve of claim 18, said guide means further comprising a slot extending into said elongate member of said slider valve.

20. The automatic, pressure responsive air intake valve of claim 18, said second bore in said slider valve member further comprising: a cavity within said slider valve member, said cavity being defined by a sidewall of said second bore and having a contour of a portion of an interior of a sphere; a first bore section extending generally parallel to a major axis of said slider valve member from said top face of said slider valve member to said cavity; and said side port extending at an angle to said major axis of said slider valve member and terminating at said cavity; whereby air flowing through said second bore is directed along said major axis, through a turn along the spherical contour of said cavity, and out from said side port while maintaining laminar flow.

21. The automatic, pressure responsive air intake valve of claim 20, wherein said port extends generally perpendicular to said major axis of said slider valve member.

22. The automatic, pressure responsive air intake valve of claim 15, further

comprising: a plurality of said air intake valves positioned within said cylinder head.

23. The automatic, pressure responsive air intake valve of claim 22, each of said valves being positioned so as to direct a flow of air through said valve and radially within said working cylinder, whereby the plurality of air flows from said plurality of valves produce a uniform, swirling airflow within said working cylinder.

24. The automatic, pressure responsive air intake valve of claim 15, said valve seat housing being formed integrally within said cylinder head.

AMENDED CLAIMS

[received by the International Bureau on 30 March 2001 (30.03.01) original second claim 12 cancelled ; original claim 1 amended ; new claim 25 added; remaining claims unchanged (6 pages)]

1. In a two stroke internal combustion engine comprising an elongate power cylinder having a piston operatively connected to a drive shaft through a connecting rod and mounted for reciprocating movement therein between a top dead center position adjacent a first end of said power cylinder and a bottom dead center position adjacent a second end of said power cylinder, an air inlet adjacent said first end of said power cylinder interconnecting said power cylinder with a source of compressed air, an automatic pressure-responsive valve mounted within said air inlet, and an exhaust outlet positioned away from said second end of said power cylinder a sufficient distance such that said exhaust outlet is entirely exposed only when said piston is at said bottom dead center position and is at least partially blocked by said piston at all other times, a method of conducting a two stroke cycle within said power cylinder comprising the steps of:

a. admitting a charge of compressed air into said power cylinder in response to a pressure differential across said pressure responsive valve created by the downwardly moving piston, exposing said exhaust outlet, said charge of compressed air being admitted while said exhaust outlet is at least partially exposed;

b. compressing said air in the power cylinder by the upwardly moving piston with exhaust port closed;

c. adding fuel to said charge of air during such compression to create a compressed air/fuel mixture;

d. combusting said air/fuel mixture to drive said piston downward through said power cylinder; and

e. ventilating combustion products from said power cylinder at the instant that said piston begins to expose said exhaust port during a downstroke of said piston and simultaneously with admitting fresh, cool, compressed air into said power cylinder to create an airflow along a longitudinal axis of said power cylinder from said air inlet to

said exhaust outlet;

whereby the creation of an airflow along a longitudinal axis of said power cylinder from said air inlet to said exhaust outlet cools said power cylinder as such air travels from said air inlet to said exhaust outlet.

2. The method according to claim 1, wherein when said piston moves from said bottom dead center position back toward said top dead center position, said exhaust outlet is closed and pressure builds in said power cylinder until said pressure responsive valve closes, thereby trapping and compressing air therein.

3. A forced coaxially ventilated two stroke power plant comprising:

a source of compressed air; and

an elongate power chamber having a first end and a second end opposite said first end, said power chamber in fluid communication with said source of compressed air, said power chamber further comprising:

a piston mounted for reciprocating movement within said power chamber between a top dead center position adjacent said first end and a bottom dead center position adjacent said second end, said piston being mounted to a connecting rod which in turn is operatively connected to a drive shaft;

an air inlet adjacent said first end, said air inlet interconnecting said source of compressed air and said power chamber;

a first automatic pressure responsive valve mounted within said air inlet for admitting a charge of compressed air from said source of compressed air in response to a pressure differential across said first pressure responsive valve; and

an exhaust outlet positioned away from said second end a sufficient distance such that said exhaust port is entirely exposed only when said piston is at said bottom dead center position, and is at least partially blocked by said piston at all other times; whereby exposure of said exhaust outlet creates an airflow generally coaxial

means.

10. The forced coaxially ventilated two stroke power plant of claim 9, wherein said air inlet means is positioned adjacent said first end, and said exhaust means is positioned away from said second end a sufficient distance such that said exhaust port is entirely exposed only when said piston is at said bottom dead center position, and is at least partially blocked by said piston at all other times.

11. The forced coaxially ventilated two stroke power plant of claim 10, wherein said first automatic, pressure responsive valve means is configured to automatically open upon ventilation of said power cylinder through exposure of said exhaust means, such that an airflow generally coaxial with said power cylinder is generated flowing from said air inlet means to said exhaust means, and cools said power cylinder as it flows from said air inlet means to said exhaust means.

12. The forced coaxially ventilated two stroke power plant of claim 11, said first automatic, pressure responsive valve means further comprising:

a valve seat housing, said valve seat housing further comprising,

a first bore extending through said valve seat housing from a top face of said valve seat housing to a bottom face of said valve seat housing, said first bore defining a flared valve seat adjacent said bottom face,

and a slider valve member configured for reciprocating movement through said bore, said slider valve member further comprising: an elongate member having an outwardly flared bottom, said outwardly flared bottom configured to mate with said valve seat to close said valve;

guide means for guiding said slider valve through said valve seat housing;

a side port extending into a side wall of said elongate member; and

a second bore extending through said slider valve member from a top face of

said slider valve member to said side port.

13. The forced coaxially ventilated two stroke power plant of claim 9, said air supply means further comprising an induction cylinder having a first end and a second end, said induction cylinder further comprising:

an air induction inlet in fluid communication with atmospheric air;

an air outlet in fluid communication with said air inlet means of said power cylinder: and

a piston mounted for reciprocating movement within said induction cylinder between a top dead center position adjacent said first end of said induction cylinder and a bottom dead center position adjacent said second end of said induction cylinder.

14. The forced coaxially ventilated two stroke power plant of claim 14, further comprising a second automatic, pressure responsive valve means mounted within said air induction inlet.

15. In an internal combustion engine having at least one working cylinder, said cylinder further comprising a cylinder head, an automatic, pressure responsive air intake valve comprising: a valve seat housing, said valve seat housing further comprising: a first bore extending through said valve seat housing from a top face of said valve seat housing to a bottom face of said valve seat housing, said first bore defining a flared valve seat adjacent said bottom face; and a slider valve member configured for reciprocating movement through said bore, said slider valve member further comprising: an elongate member having an outwardly flared bottom, said outwardly flared bottom configured to mate with said valve seat to close said valve; guide means for guiding said slider valve through said valve seat housing; a side port extending into a side wall of said elongate member; and a second bore extending through said slider valve member from a top face of said slider valve member to said

21. The automatic, pressure responsive air intake valve of claim 20, wherein said port extends generally perpendicular to said major axis of said slider valve member.

22. The automatic, pressure responsive air intake valve of claim 15, further comprising: a plurality of said air intake valves positioned within said cylinder head.

23. The automatic, pressure responsive air intake valve of claim 22, each of said valves being positioned so as to direct a flow of air through said valve and in a tangential direction to a radius of said working cylinder, whereby the plurality of air flows from said plurality of valves produce a uniform, swirling airflow within said working cylinder.

24. The automatic, pressure responsive air intake valve of claim 15, said valve seat housing being formed integrally within said cylinder head.

25. A forced coaxially ventilated two stroke power plant comprising:

an elongate power cylinder having a first end and a second end opposite said first end, and piston means operatively connected to a drive shaft and mounted for reciprocal movement within said power cylinder between a top dead center position adjacent said first end and a bottom dead center position adjacent said second end;

air supply means in fluid communication with said elongate power cylinder centrally at said first end for supplying air proximate the top dead center position of said piston means;

first automatic pressure responsive valve means in fluid communication with said air supply means for admitting a charge of said compressed air from said air supply means in response to a pressure differential;

an exhaust port in fluid communication with said elongate power cylinder

proximate said second end for exhausting combustion product proximate the bottom dead center position of said piston means.

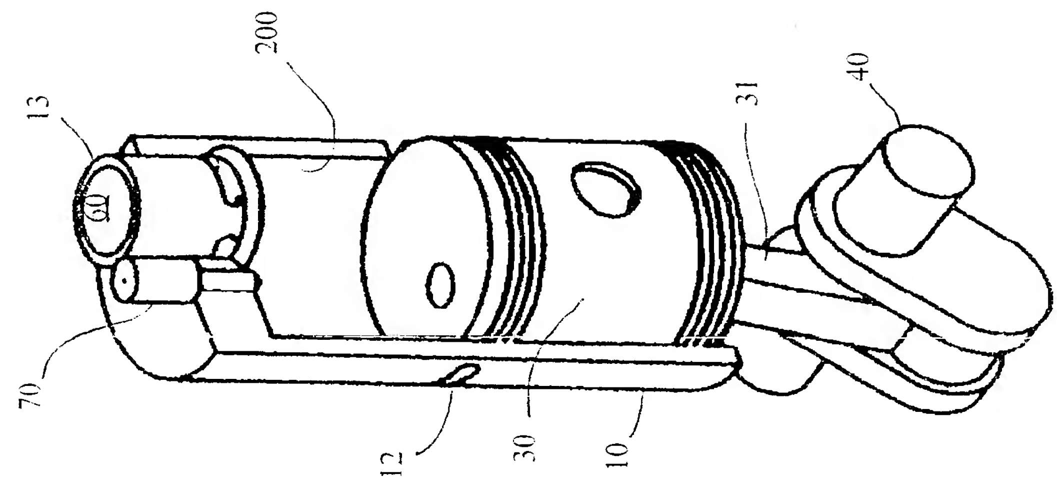

FIG. 2

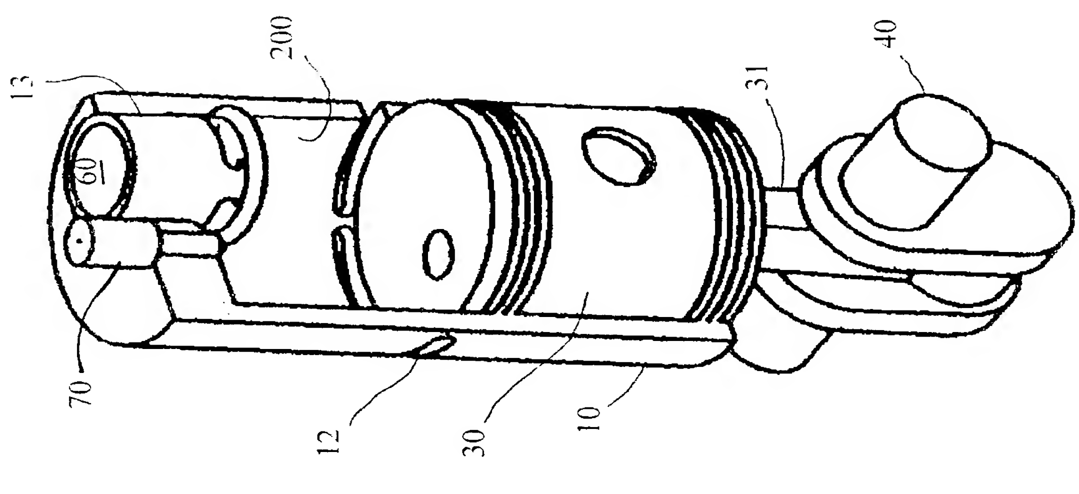

FIG. 1

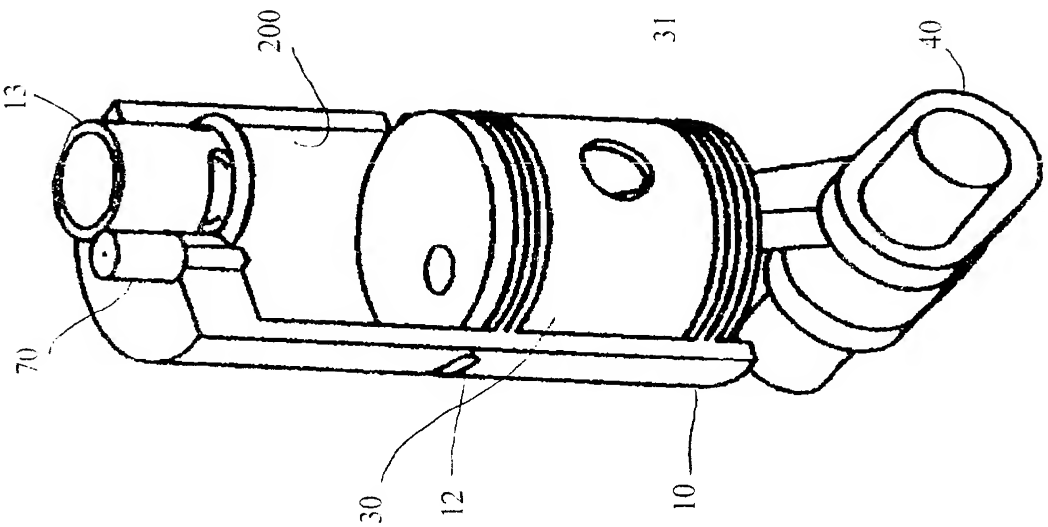

FIG. 4

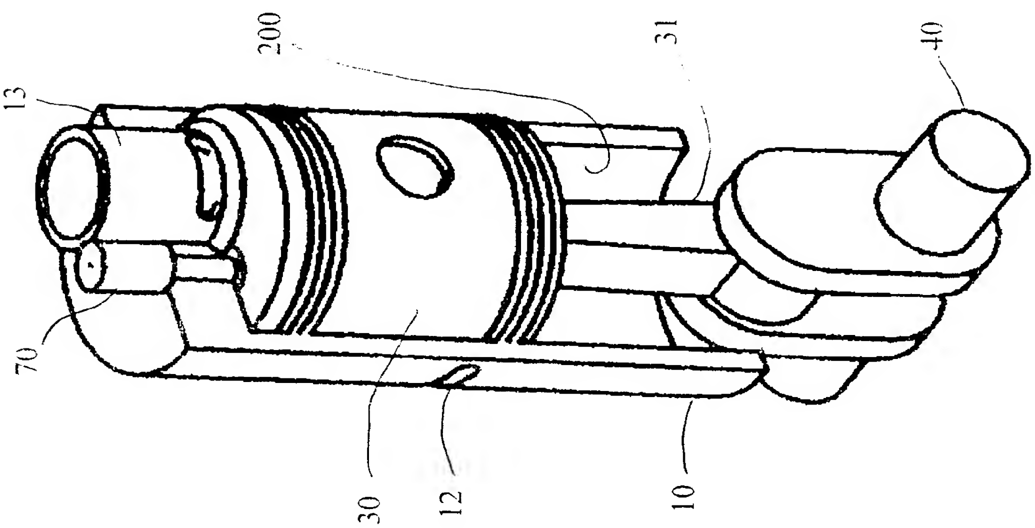

FIG. 3

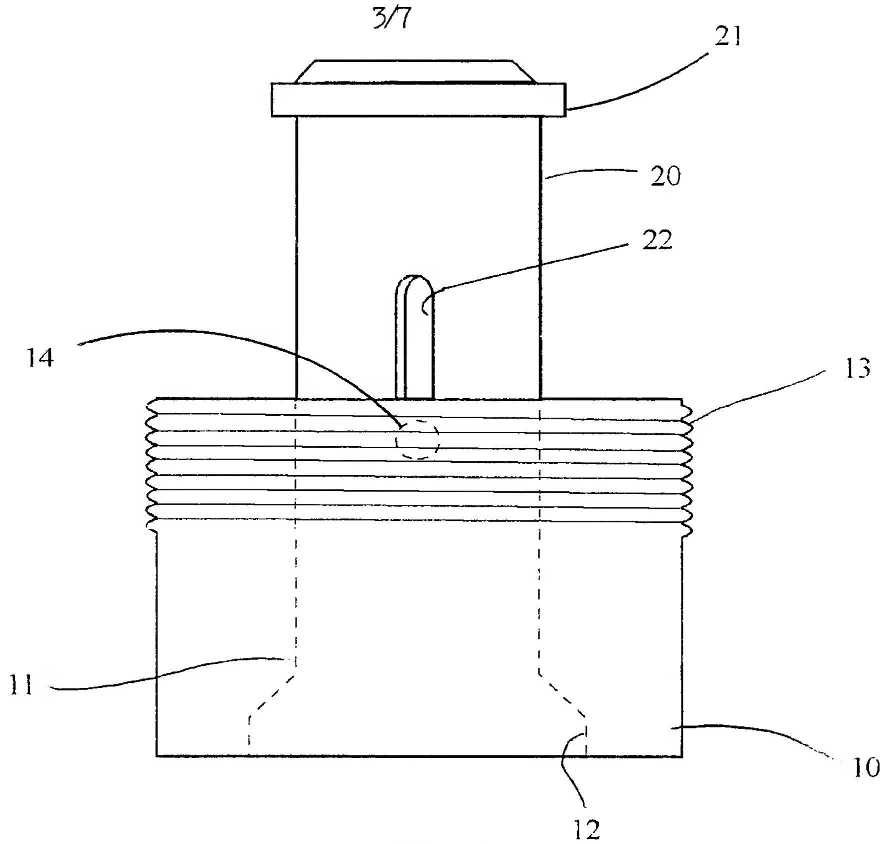

FIG. 5

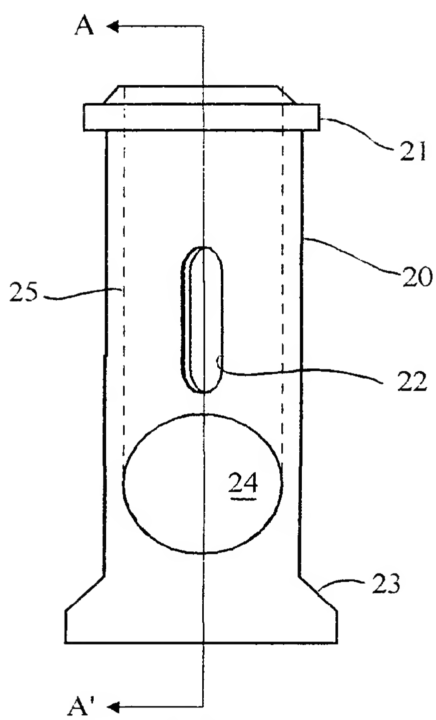

FIG. 6

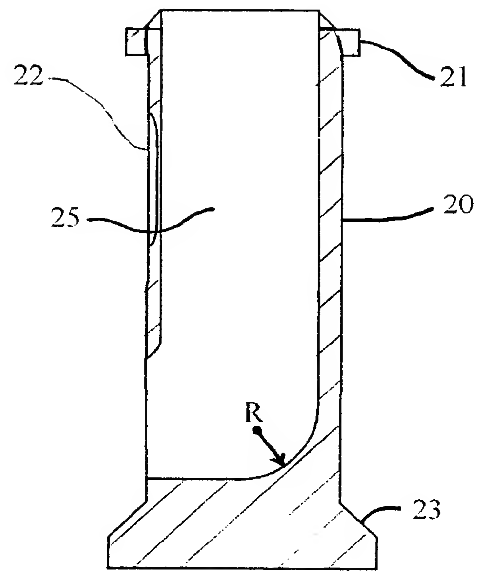

FIG. 7

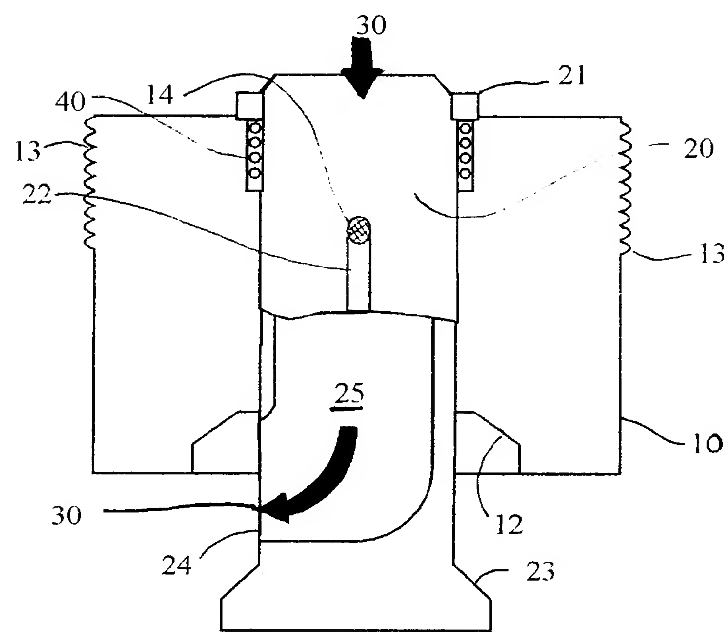

FIG. 8

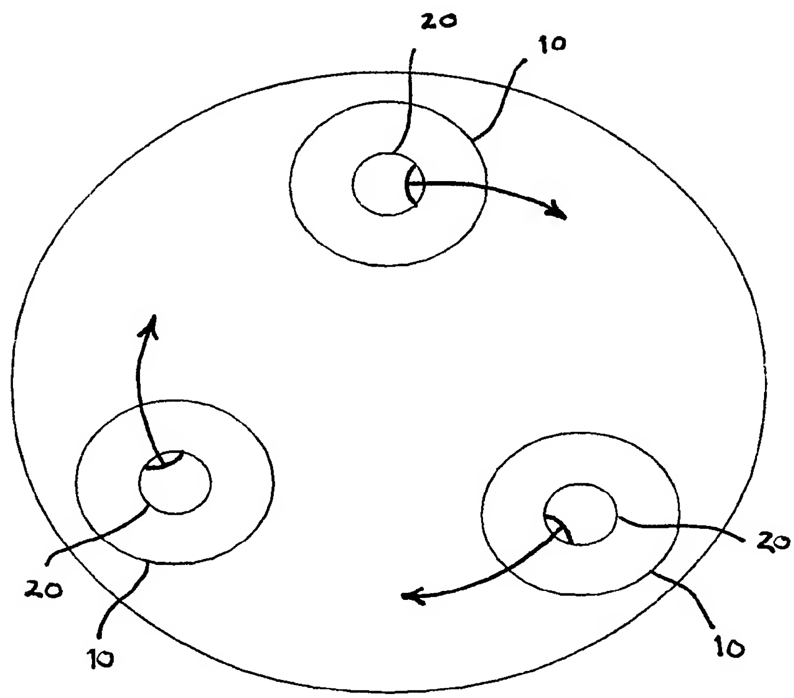

FIG. 9

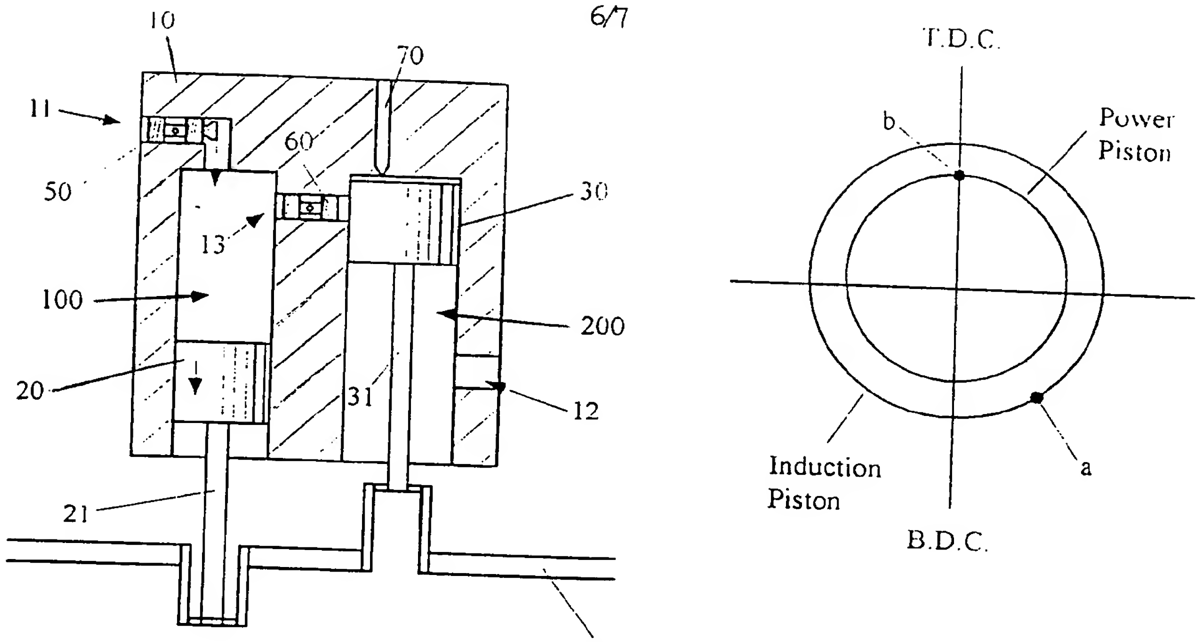
10
11
70
60
50
30
13
100
200
20
31
12
21
40
T.D.C.
b
Power
Piston
Induction
Piston
a
B.D.C.

Fig. 10

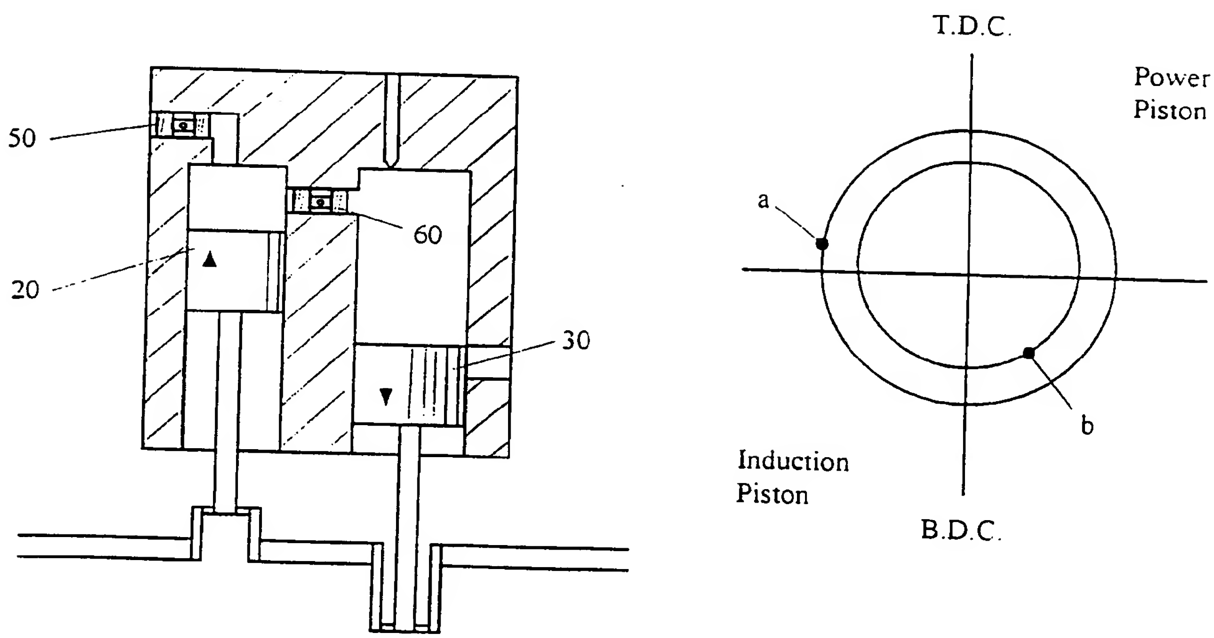
50
60
20
30
T.D.C.
Power
Piston
a
b
Induction
Piston
B.D.C.

Fig. 11

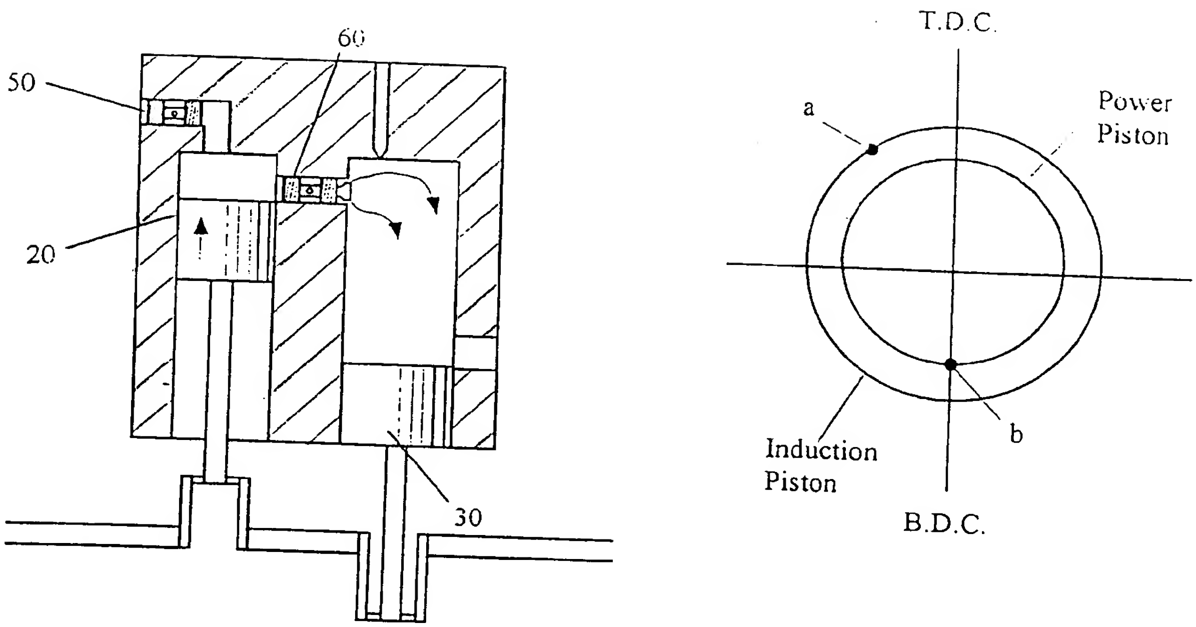
60
50
20
30
T.D.C.
a
Power
Piston
b
Induction
Piston
B.D.C.

Fig. 12

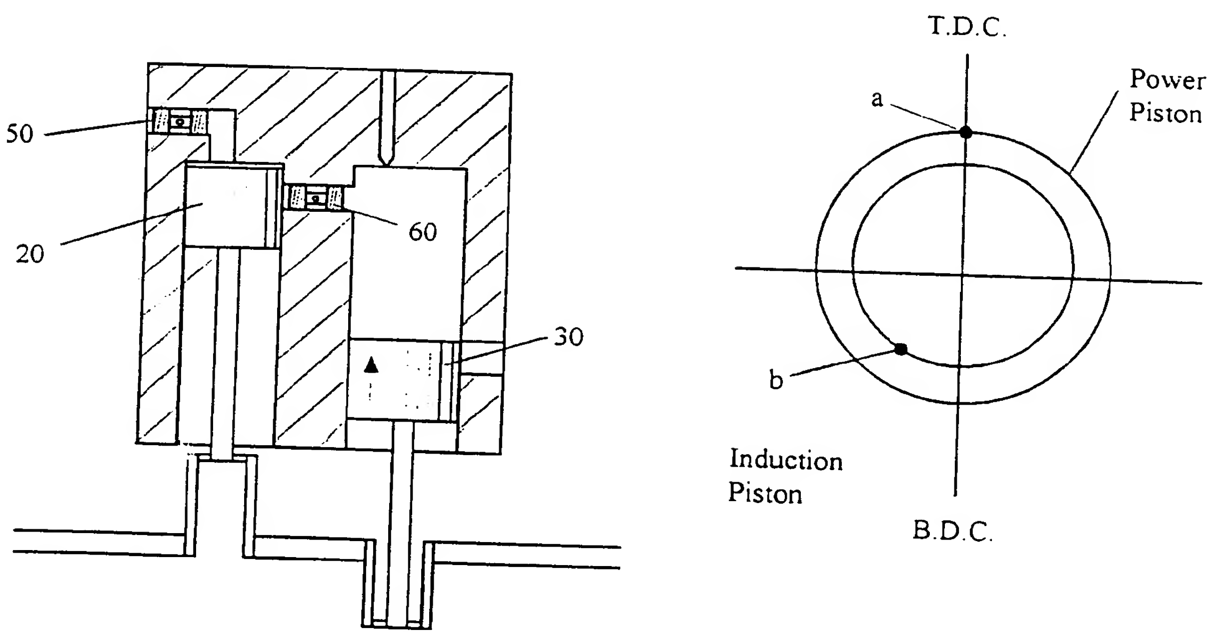
50
20
60
30
T.D.C.
a
Power
Piston
b
Induction
Piston
B.D.C.

Fig. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/30978

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :F02B 33/00
US CL :123/65R, 70R, 70V, 188.4, 188.2; 137/528, 538
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 123/65R, 70R, 70V, 188.4, 188.2; 137/528, 538

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,275,134 A (SPRINGER) 04 JANUARY 1994, FIGURE 3.	1-3, 5-11, 13-14
A	US 4,058,091 A (TANAHASHI) 15 NOVEMBER 1977, ENTIRE DOCUMENT.	1-24
A	US 5,020,486 A (UNGER) 04 JUNE 1991, ENTIRE DOCUMENT.	1-24
A	US 3,987,769 A (YEW) 26 OCTOBER 1976, ENTIRE DOCUMENT.	1-24
A	US 5,647,309 A (AVERY) 15 JULY 1997, ENTIRE DOCUMENT.	1-24
A	US 2,522,649 A (TENNEY) 19 SEPTEMBER 1950, ENTIRE DOCUMENT.	1-24

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,462,082 A (LAURIA) 31 OCTOBER 1995, ENTIRE DOCUMENT.	1-24
A	US 4,781,155 A (BRUCKER) 01 NOVEMBER 1988, ENTIRE DOCUMENT.	1-24
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